Space Weather Technical Forecast

Issued on Tuesday, 18 July 2023 at 01:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Minor/Moderate R1/R2 Blackouts likely throughout. Chance of G1Minor Storms during 18 July.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Moderate with a particularly long duration M-class flare observed and reaching M5.6 at 17/2359 UTC from AR3363 located in the southwest and currently nearing the limb. This large region in the southwest, AR3363 also gave a number of C-class flares as did another large region AR3373 in the northeast. There are currently eight numbered regions on the visible disc. A number of CMEs (Coronal Mass Ejections) were observed leaving the Sun over the past 24 hours, however none of them are currently considered Earth-directed. The largest and fastest CMEs originated from a region located well beyond the western horizon. Further CMEs from the large region in the southwest, AR3363, have been analysed as not being Earth-directed, although the recent impressive flare is likely to have generated a CME which will be analysed in the coming hours.

Solar Wind / Geomagnetic Activity: The solar wind is now at elevated levels around 530 km/s, following the arrival of a CME around 16/1800 UTCC that probably left the sun on 14 July. The solar wind rose from slightly elevated levels. The total magnetic field (IMF), Bt, was initially at moderate levels, with an initial peak observed at 14 nT, but then steadily weakened and is now Weak at around 6 nT. The density also rose from below average to average levels with a peak of 5ppcc. The north-south component started t Weal levels before then becoming moderately southward between 17/0500 UTC and 17/1000 UTC to reach a minimum of -10nT. Phi angle was consistently negative (towards the Sun). Geomagnetic activity was at Quiet to Unsettled levels (Kp2-3) with periods of Active (Kp4) due to effects of the CME arrival on the Earths magnetic field. A G1/Minor Storm interval was observed between 17/0600-170900UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, has fitfully declined from around 1 pfu and has now fallen below the 1 pfu level. High energy electron flux (greater than 2MeV) was at background levels. The 24-hour integrated fluence was below the Active (1e8 integrated pfu) threshold on a decreasing trend. A fluence of 4.6e6 pfu was recorded at 17/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain at Low to Moderate levels, with a slight chance of an X-class flare, probably most likely from the aforementioned large sunspot region AR3373 in the northeast.

Solar Wind / Geomagnetic Activity: Current CME influence is expected to gradually ease into 18 July. A fast solar wind could then connect on 18 and 19 July, but this is low confidence due to the weak appearance of the feature. Solar wind conditions are then forecast to decline towards background from later on 19 and into 20 July. Unsettled to Active (Kp3-4) geomagnetic activity is likely at first, with a Chance of G1/Minor geomagnetic storms (Kp5). Ongoing CME effects are

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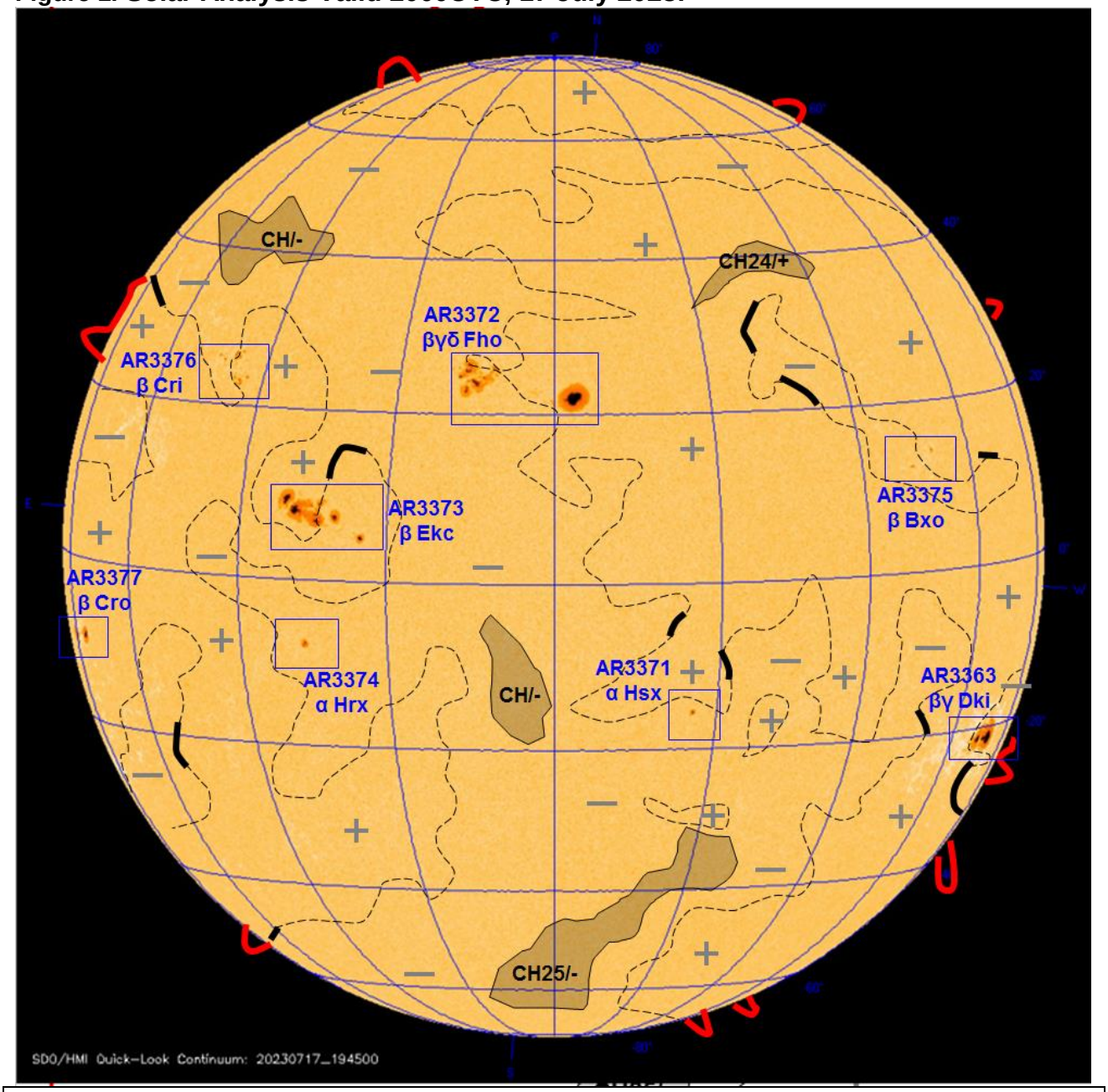
expected into 18 July, before gradually easing back to mainly Quiet with Unsettled (Kp1-3) spells by 19 Jul. However any further enhancement from the fast solar wind is likely to bring a spell of Active (Kp4) conditions, most likely on 19 July.

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight chance of reaching the S1/Minor Storm threshold through the period, should any large flares occur. However the probability is low and expected to decrease over the following days. High energy electron flux (greater than 2MeV) is expected to be at mostly background, perhaps briefly moderate to high later in the period, however fluence is most likely to remain below the Active (1e8 integrated pfu) threshold throughout with only a low risk of reaching the active threshold on 19 or 20 July.

Figure 1. Solar Analysis Valid 2000UTC, 17 July 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

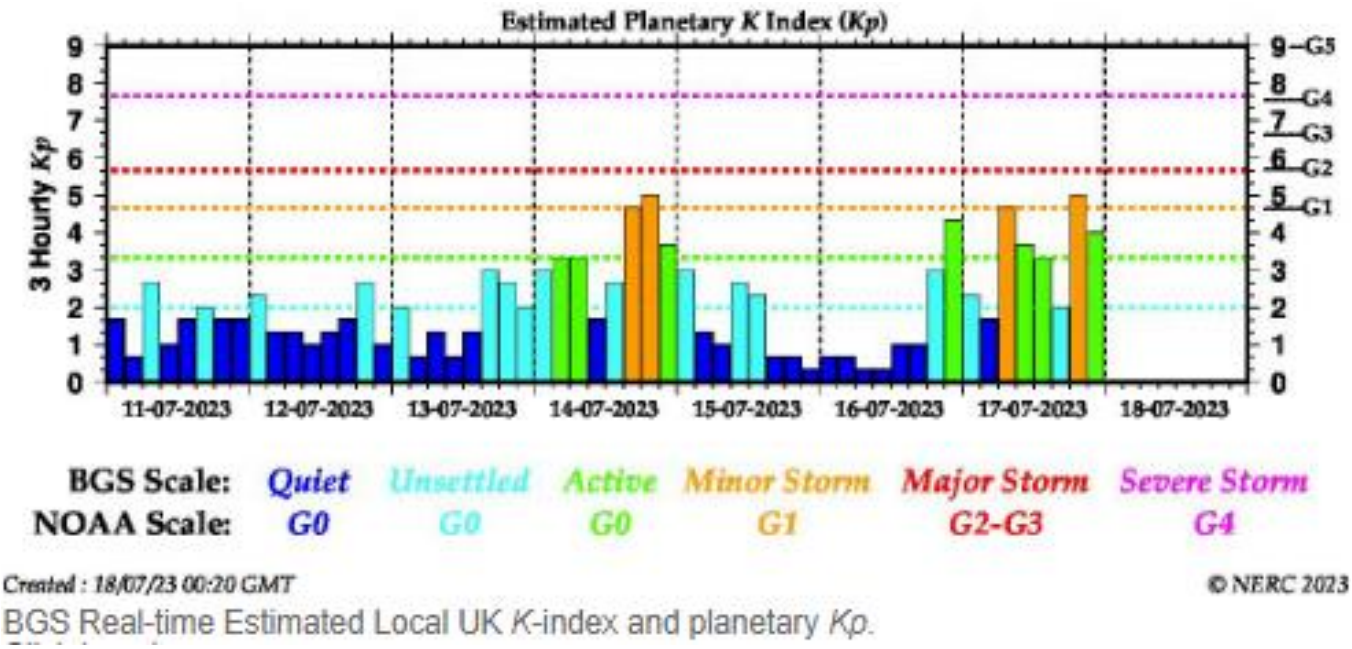
There is ongoing influence from a CME which arrived at Earth late on 16 July, with a Chance assessed as 40% for further G1/Minor Storms. These effects declining into day 2 (19 July). A coronal hole high speed stream from CH24 is then possible by day 2 (19 July), although as this is a small feature, limited enhancements are anticipated which may be masked by the continuing CME effects. Geomagnetic activity is therefore expected to be Unsettled to Active on day 1 (18 July) with Active or G1Minor storms possible. Active intervals are then likely into day 2 (19 July) as CME effects wane and more especially if the coronal hole high speed stream connects favourably with Earth. Declining activity is then expected through days 3 and 4 (20 and 21 July), with geomagnetic activity probably returning to mostly Quiet (Kp1-2) levels.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	5	1	1
Strong	G3	No	10	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: Geomagnetic activity over past 24 hours as shown by BGS plot below.



BGS Real-time Estimated Local UK *K*-index and planetary *Kp*.

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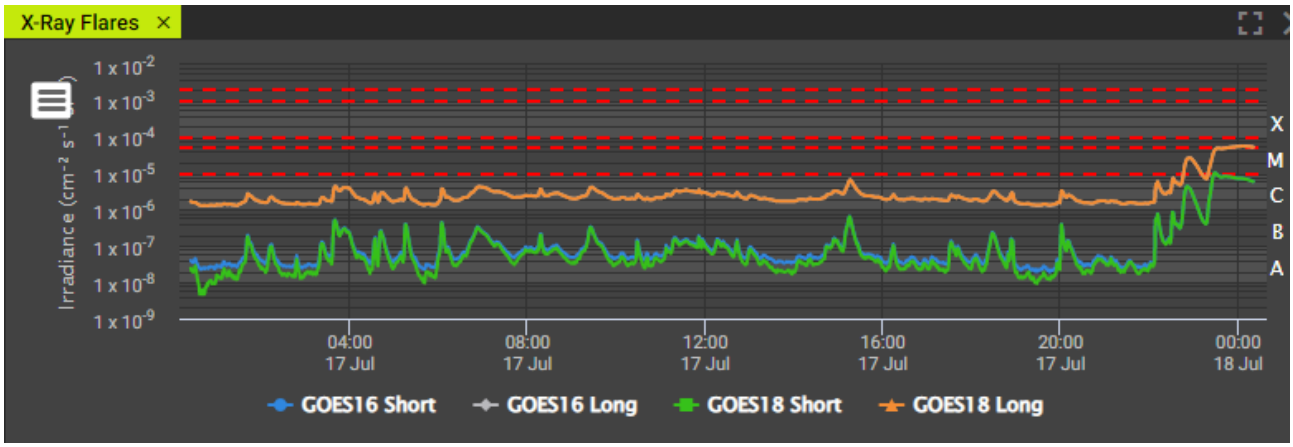
Radio Blackouts - X-Ray Flares:
There are eight numbered sunspots on the visible disc. AR3363 is the most active, and continues to show a decrease in areal extent. AR3372 is a large open region, consisting of a simple symmetric leader and a more complex broken trailer that includes occasional, small delta spots. AR3373 continues to show further growth in its intermediate region with development of mature penumbra. AR3376 is newly numbered in the northeast and has shown some intermediate spot emergence, but mostly umbra currently. The newly numbered region AR3377 on the southeast limb appears bi-polar but relatively simple. The remaining regions appear stable and relatively small. Solar activity is Moderate with an M-class flare observed, peaking M5.6 at 17/2359 UTC from AR3363. Further M-flares remain likely with Low to Moderate activity most likely to continue. There is a slight chance of an isolated X-class flare, probably from AR3373 in the northeast.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	70
Very Active	R3 to R5 X Class	No	10	10	10	20

Figure 3: X-ray flux plot at GEO from GOES. Note the recent long duation M-class flare from AR3363.



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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux rose to be above the S1 threshold (10 pfu) 16/0635-0905UTC, before gradually easing back towards background. This rise was likely due to a significant flare, associated with a fast CME that was observed on the far-side, just over the western horizon early on 16 July. Flux continues to decline towards background but there is a continuing risk from any flaring, mainly from sunspots on the western hemisphere disc, or further events over the western limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	15	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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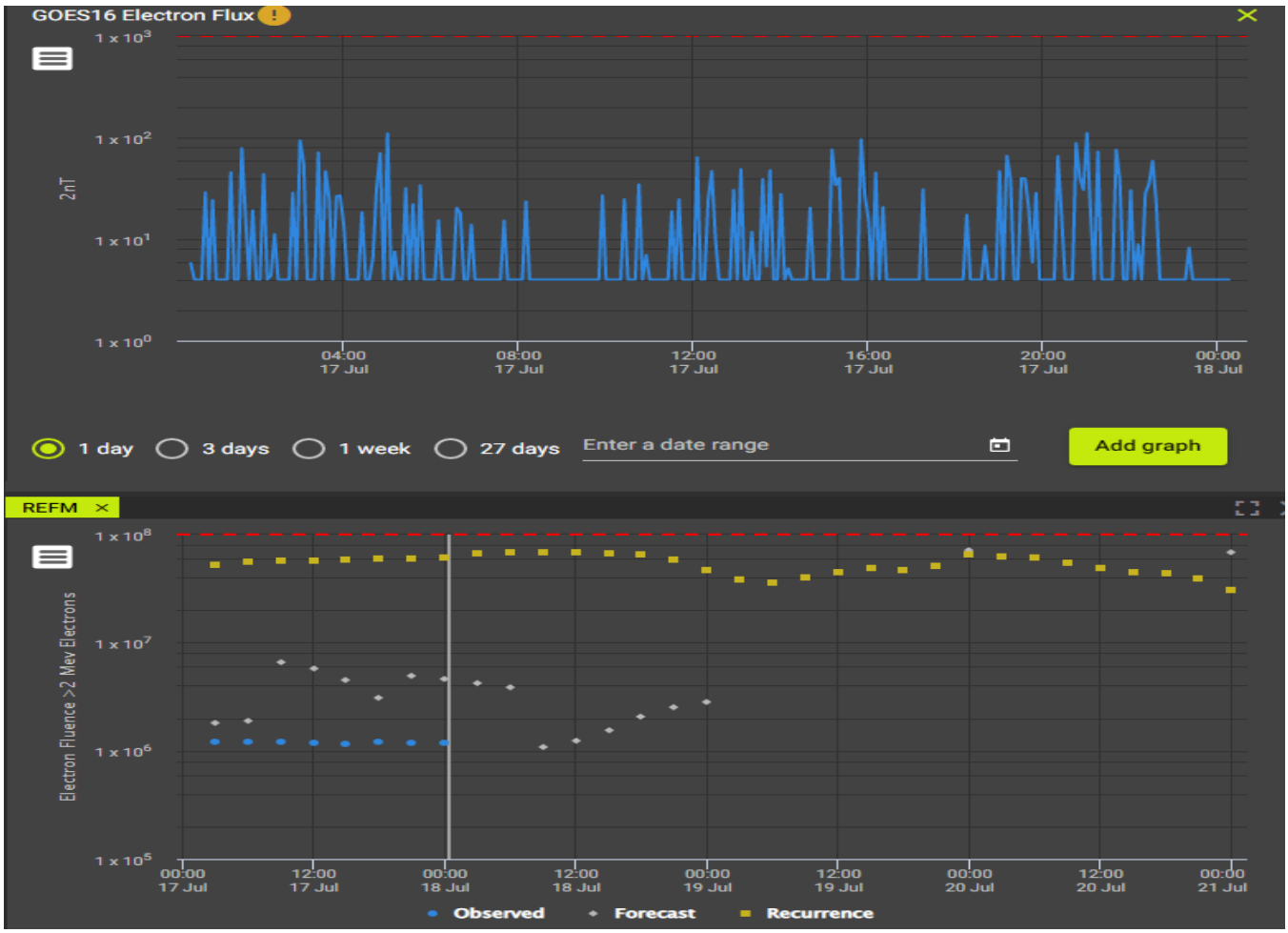
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) is forecast to be mainly background initially due to suppression from geomagnetic activity and distortion of the radiation belts from the stronger and denser solar wind. Waning effects through 19 and 20 July may then result in an increase, with the magnitude of this dependent on the level of transfer of particles from the CME and any high speed stream to the radiation belts.
Electron fluence values are also well below the Active (1e8 integrated pfu), with relatively low confidence in the increase towards the threshold later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	20	20	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: High energy electron flux at GEO from GOESand Met Office REFM output.



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